

## DOCUMENT RESUME

ED 146, 653

HE 009 419

**AUTHOR** Atelsek, Frank J.; Gomberg, Irene L.  
**TITLE** Production of Doctorates in the Biosciences, 1975-1980: An Experimental Forecast, Higher Education Panel Reports, No. 34.  
**INSTITUTION** American Council on Education, Washington, D.C.  
**SPONS AGENCY** Higher Education Panel?  
**NATIONAL INSTITUTE** National Institutes of Health (DHEW), Bethesda, Md.; National Science Foundation, Washington, D.C.; Office of Education (DHEW), Washington, D.C.  
**PUB DATE** Nov 77  
**GRANT** SRS-7617080  
**NOTE** 39p.  
**AVAILABLE FROM** Higher Education Panel, American Council on Education, One Dupont Circle, Washington, D.C. 20036  
**EDRS PRICE** MF-\$0.83 HC-\$2.06 Plus Postage.  
**DESCRIPTORS** Anatomy; Biochemistry; \*Biological Sciences; Biology; Biophysics; Botany; Cytology; \*Degrees (Titles); Departments; \*Doctoral Degrees; Ecology; \*Enrollment Projections; Enrollment Trends; Entomology; Federal Aid; Genetics; \*Graduate Study; Higher Education; Microbiology; National Surveys; Nutrition; Pathology; Pharmaceutical Education; Physiology; Private Colleges; State Universities; Zoology  
**IDENTIFIERS** Biometrics; Toxicology.

## ABSTRACT

A survey was undertaken in 1976 to obtain short-term estimates of doctorate production directly from the heads of the science departments involved. These biosciences departments were surveyed in the 235 member institutions of the Higher Education Panel that grant doctorates: anatomy, biochemistry, biology, biometry/biostatistics/biomathematics, biophysics, botany, cell biology, ecology, entomology/parasitology, genetics, human pathology, microbiology, nutrition, pharmacology/toxicology, physiology, zoology, and others. The overall response rate was 93 percent. According to the aggregated responses doctorate production will increase 59 percent over the rest of the decade, with a sharp rise in both private and public institutions. The largest numerical gain is anticipated for public institutions, which currently account for nearly three-fourths of all biosciences doctorates awarded. Almost one-fourth of the doctorates in 1975-76 were awarded by the 20 institutions receiving the highest level of National Institutes of Health research support. Fields that accounted for the greatest numbers of doctorates were biology and biochemistry. Other findings are presented in narrated and tabular form. (MSE)

ED146853  
HE009419

# Production of Doctorates in the Biosciences, 1975-1980: An Experimental Forecast

Frank J. Atelsek and Irene L. Gomberg

U.S. DEPARTMENT OF HEALTH,  
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HIGHER EDUCATION PANEL REPORTS, NUMBER 34  
AMERICAN COUNCIL ON EDUCATION

NOVEMBER  
1977

A Survey Funded by the National Science Foundation, the U.S. Office of Education,  
and the National Institutes of Health

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The Higher Education Panel's surveys on behalf of the Federal Government are conducted under grant support provided jointly by the National Science Foundation, the National Institutes of Health, and the U. S. Office of Education (NSF Grant SRS-7617080).

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Number 34 November 1977

American Council on Education  
Washington, D.C. 20036

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Acknowledgments

This survey received the guidance and assistance of the Panel's Federal Advisory Board and its Technical Advisory Committee. Joseph Steinberg of Survey Design, Inc., advised us on the methodology for weighting the results to national estimates.

Special thanks are due Richard Giza, survey coordinator for the National Institutes of Health, and George Bowden, from the Office of Resources Analysis, Special Projects Branch at NIH, who provided many of the ideas as well as the framework for this report.

Most of all, we wish to acknowledge our gratitude to the Higher Education Panel institutions and our representatives on each campus. We are beholden to them for their continued cooperation and assistance in all our survey efforts.

### Background

Available techniques for projecting biomedical research manpower have not, by and large, yielded satisfactory results for planners concerned with anticipating prospective supply/demand imbalances. Such techniques have typically relied on changes in past enrollment patterns and have only partially and indirectly reflected the immediate circumstantial factors which may impact--often uniquely--on the production of Ph.D.-trained biomedical research manpower.

To explore an alternative forecasting approach which would more adequately take account of such factors, the National Institutes of Health asked the American Council on Education to conduct this survey of its Higher Education Panel. The survey was designed to obtain short-term estimates of doctorate production directly from the heads of the science departments involved. Specifically, respondents were asked, first, to indicate the number of doctorate degrees their department had awarded during the 1975-76 academic year and, second, to estimate the number it expected to award in 1977-78 and in 1979-80.

As a basis for manpower projections, such estimates have both negative and positive features. On the negative side, they are subjective and thus vulnerable to error; on the positive side, they are more likely to incorporate economic and other highly circumstantial factors that affect the progress of graduate students toward the doctorate.

Admittedly, an effort to look ahead two to four years involves a large measure of uncertainty, whatever projection method is employed. While those who will receive the doctorate in 1977-78 or in 1979-80 have probably already begun their course of graduate study, it is virtually impossible to pinpoint exactly when each student will complete all the requirements for the degree. For example, among 1976 doctorate recipients in the biological sciences, a median of 6.9 years total time and of 5.7 years registered time elapsed between receipt of the baccalaureate and receipt of

the doctorate<sup>1</sup>. Undoubtedly, variations around these medians are considerable, adding to the difficulty of estimating precisely future doctorate production at the institutional level. Thus, caution should be observed in interpreting the estimates contained here.

#### Methods Summary

The data for this report were collected as part of a continuing research program of the Higher Education Panel, which was established at the American Council on Education in 1971 for the purpose of conducting small-scale surveys on topics of current policy interest to the higher education community and to government agencies. The Panel is now based on a network of representatives at 760 colleges and universities broadly representative of the nation's more than 3,000 institutions of higher education.<sup>2</sup>

The survey questionnaire (Appendix A) was mailed on September 1, 1976, to the 235 member institutions that grant the doctorate degree. The inquiry was specifically directed to heads of the following bioscience departments:

Anatomy	Entomology/parasitology
Biochemistry	Genetics
Biology	Human pathology
Biometry/biostatistics/ biomathematics	Microbiology
Biophysics	Nutrition
Botany	Pharmacology/toxicology
Cell Biology	Physiology
Ecology	Zoology
	Other biosciences

To assure complete coverage, the Panel coordinator at each institution was asked to identify all bioscience departments within the institution and to indicate this

<sup>1</sup> National Academy of Sciences, National Research Council, Summary Report 1976: Doctorate Recipients from United States Universities, 1977.

<sup>2</sup> Because of the changing composition of the higher education community, a new Panel was drawn in 1976 to better represent the more than 3,000 colleges and universities in the nation. For a full discussion of the sampling procedures used, see J. A. Creager, Development of a Revised Higher Education Panel: A Study of the Taxonomy and Sampling of the Institutional Domain of Higher Education, Final Report (NSF Grant #SRS75-14621) 1976.

information on a return postcard which was mailed with the survey instrument.

Completed questionnaires were received from all departments at 174 institutions, with partial but usable data provided by an additional 14 institutions, for an overall response rate of 93 percent<sup>3</sup>. The data were subsequently weighted by a two-stage ratio estimation procedure (Appendix B). Thus, the weighted results given in this report represent independently computed population estimates, not exact counts:

Figures for 1975-76 are actual numbers of degrees conferred, weighted to national estimates; figures for 1977-78 and 1979-80 represent the personal judgments of department heads as to the probable numbers of degrees to be conferred two and four years from the date of the survey. These estimates were also weighted to provide national totals.

#### Findings

According to the aggregated responses of department heads, doctorate production in the biosciences will increase 59 percent over the rest of the decade, from a level of approximately 3,400 in 1975-76, to 5,000 in 1977-78 and 5,400 in 1979-80 (Table 1). This sharp rise in doctorate production is anticipated at both public and private institutions, with the largest numerical gain indicated for public institutions, which currently account for nearly three-fourths of all bioscience doctorates awarded (Tables 2 and 3).

Almost one-fourth of the bioscience doctorates in 1975-76 were awarded by the "Top 20" institutions--those receiving the highest level of NIH research support (Table 4); the "Bottom 20" awarded less than 5 percent of all 1975-76 bioscience doctorates (Table 5).

Fields which accounted for the greatest number of 1975-76 doctorates were biology and biochemistry (each of which awarded about 15 percent of the total) and microbiology (accounting for 11 percent). It is noteworthy that larger proportions

<sup>3</sup> In the course of the survey it was learned that 33 Panel institutions did not award doctorates in the biosciences. Thus, the survey base within the Panel was reduced to 202.

of doctorates were conferred at public than at private institutions in zoology, botany, and entomology/parasitology, while private institutions awarded proportionately more doctorates in biology and pharmacology/toxicology, (Table 6).

Before examining specific field-by field variations in future doctoral output, it is appropriate to inquire into the reliability of these departmental projections. No assumptions were provided department heads completing the questionnaires; estimates are derived in large measure from respondents' subjective judgments as to the rate at which graduate students would complete work for the doctorate. Some department heads may have based these judgments on recent enrollment trends; others, on the number of years their students had already spent as doctoral candidates; still others, on the students' progress toward the degree in terms of coursework and examinations required. Given the wide variation in the number of years required to complete work for the doctorate, the respondents would have found it difficult to develop a systematic method of estimation. In the biosciences, combination programs (M.D.-Ph.D. or M.A.-Ph.D.) make such estimates even more tenuous.

To ascertain the basis of these estimates, a small group of respondents who had anticipated sharp increases in doctorate production between 1975-76 and 1977-78 were contacted by telephone after the initial survey. Of these, over 70 percent provided specific reasons for assuming that their departments would graduate larger numbers of doctoral students: newly approved doctoral programs, increased sponsorship and funds, additional faculty, newly expanded departments.

Despite the results of this telephone check, it is possible that the unexpectedly high projections indicated for the biosciences may, in part, reflect a reporting artifact. Most bioscience departments award only a few doctorates in a given year. In 1975-76, for example, 74 percent of the responding departments awarded fewer than four doctorates in their fields. Considering that nearly 1,200 separate field responses were made to the HEP survey, an overestimate of one doctoral degree by a number of departments, when cumulated, would introduce a substantial source of error.

Unfortunately, the extent of such distortion cannot be determined because of the subjective nature of the departmental estimates.

Recent projections of Ph.D. output developed by the National Institutes of Health afford a useful framework for testing the fit of the estimates obtained from the present HEP survey (see chart). The NIH projections are based on known first-year, full-time graduate enrollment levels and the distribution of Ph.D.'s by time lapse since graduate entry.

A distribution of bioscience doctorates (since FY 1961), constructed by year of graduate entry and by time lapse to receipt of the doctorate, indicates that the proportion of graduate students receiving the Ph.D. varies considerably from year to year of graduate entry. In the NIH projection method, an appropriate distribution of the proportions of entering graduate classes who receive the doctorate after various time lapses is multiplied by the appropriate first-year graduate enrollment figures and then aggregated to yield alternative distributions<sup>4</sup>:

Alternative A is based upon a 15-year average of the proportions that all doctorate-recipients represent of their respective entering classes (the upper boundary of the projection):

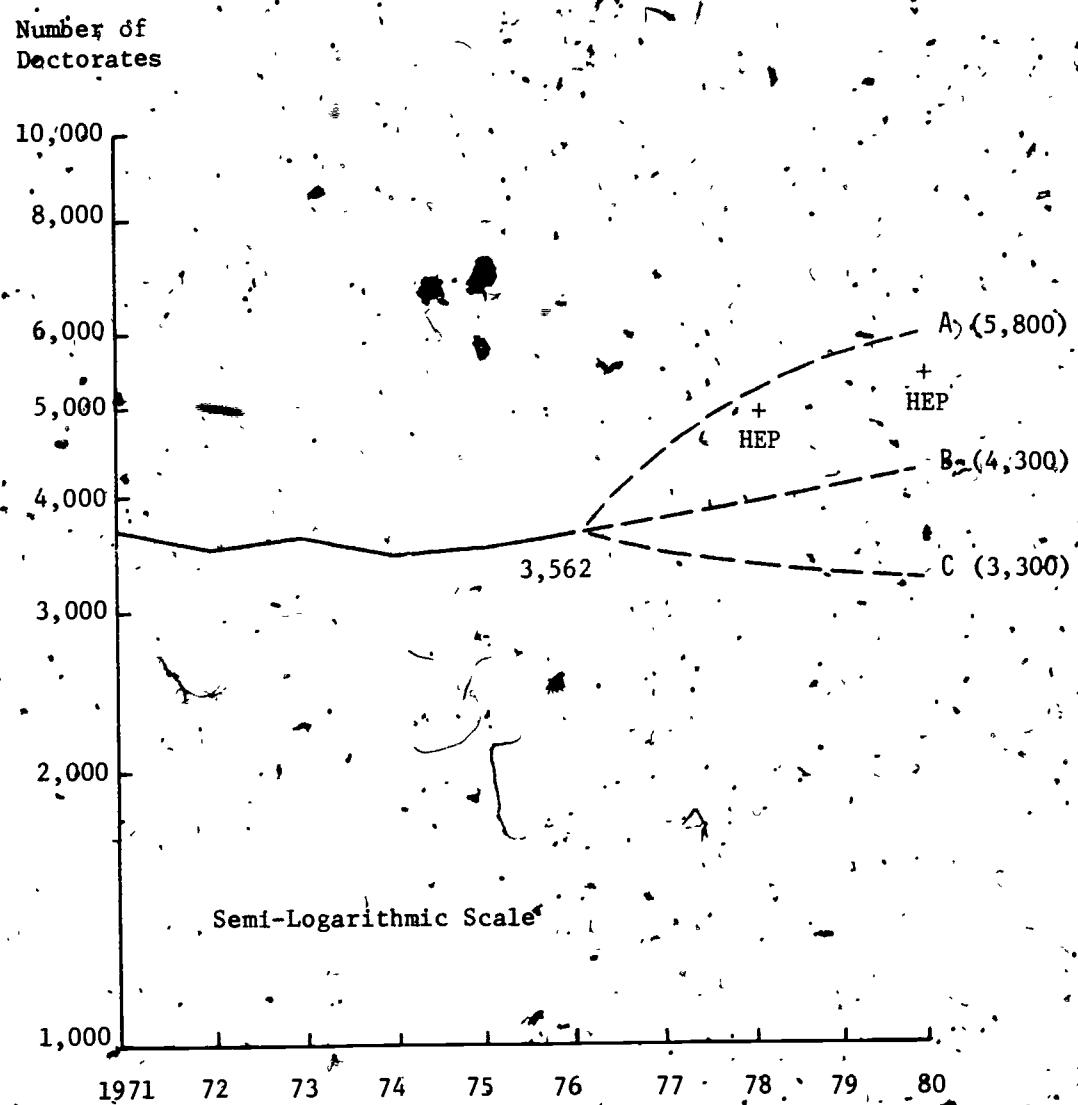
Alternative B is based upon the percentages that 1976 doctorate-recipients represent of their entering classes.

Alternative C is derived from a straight line projection of the year-to-year trends in the time lapse distribution and reflects the diminishing flow of students in recent years from graduate entry to Ph.D. (the lower boundary of the projection).

As shown, the HEP survey results fall slightly below the high projections and substantially exceed the growth rate of recent years. It is likely, then, that the projections reported here are high; however, the upward trend reflected in these projections is consonant with the fairly substantial growth in graduate enrollment in the life sciences, as reported over the past several years by the Office of

<sup>4</sup> A detailed description of this method is contained in Resources Analysis Memo No. 20, "Projections of Ph.D. Output to 1979-80 in Biosciences: A Methodology," prepared by George Bowden, National Institutes of Health (report scheduled for release in December 1977).

Doctorate Production in the Biosciences  
1971-1976 (Actual) and Alternative Projections, 1977 to 1980



Source: National Institutes of Health

Education, the National Science Foundation, and the National Institutes of Health.

Taking the statistics at their face value, it is appropriate to ask about the underlying causes of such an anticipated upward surge in bioscience doctorates.

It seems reasonable to assume that economic factors (e.g., depressed job markets) may have induced some graduate students to continue their studies toward the Ph.D.; that national efforts in the late sixties and early seventies to expand research training have borne fruit; that the influx of large numbers of part-time students into the system has affected doctoral output. Moreover, in recent years, only about one of every three applicants to medical school has been accepted into an M.D. program, and it seems likely that the resulting overflow is being absorbed into a variety of graduate programs in the biological sciences. Whatever the specific causes, graduate enrollment in the biosciences has increased substantially over the last several years (contrary to the common expectation that it would drop because of demographic factors), and this increase is likely to result in higher bioscience doctorate production in the years immediately ahead.

Although HEP survey estimates by specific field are subject to the same reservations and qualifications described above, it is believed that the data are adequate to portray gross relationships in assessing field-by-field variations.

Department heads from virtually all fields anticipated substantial increases in doctorate production between 1975-76 and 1979-80. By the end of the decade, Ph.D. output is expected to double in the fields of nutrition, biometry, anatomy, ecology and pharmacology/toxicology; much lower growth rates (between 27 and 40 percent) are expected in the fields of zoology, entomology, botany, biology, and biophysics (Table 1).

The fields expecting unusually large increases differed according to control of the institution (Tables 2 and 3). Thus, at public institutions, the greatest gains were expected in nutrition, anatomy, biometry, and pharmacology; at private institutions, the fields of ecology, botany, cell biology, and genetics were expected to experience the largest growth in doctorate production. It is significant that

public institutions account for a vast majority of Ph.D.'s awarded in the biosciences--almost 75 percent; this proportion is expected to remain stable through the four-year projection period.

The Top 20 showed a modest gain of 30 percent in overall bioscience doctorate production between 1975-76 and 1979-80; compared with a hefty 79 percent increase for the Bottom 20. In all fields except biometry and cell biology, anticipated increases in the Top 20 were below the national average. These institutions, which accounted for about 24 percent of all bioscience doctorates awarded in 1975-76, will produce only 19 percent of the doctorates in 1979-80.

If the estimates of the departmental heads prove reliable, then the relative proportion of doctorates contributed by each field will remain fairly stable (Tables 6 and 7). Similarly, with few exceptions, only minor shifts will occur in the relative proportion of degrees granted in a given field of study by public and by private institutions or by the Top and by the Bottom 20 institutions.

#### Conclusion

This report summarizes the collective expectations of department heads regarding the probable number of bioscience doctorates that will be awarded in 1977-78 and 1979-80. Such pragmatically derived estimates provide an additional dimension to existing manpower projections by incorporating the most current circumstantial factors that bear upon doctorate production--factors often inadequately considered in mathematically constructed models. While the limitations of this method are apparent, particularly with respect to assessing error resulting from an essentially subjective reporting process, it is believed that the data reported here reflect genuine tendencies and trends. Thus, while the magnitude and phasing of doctoral production in the biosciences are subject to some reservations, the probability that doctoral output will increase significantly during the remainder of the decade is high. This conclusion is also indicated (or implied) in analyses recently prepared by the National Science Foundation, the Bureau of Labor Statistics, the National Academy of Sciences, and the

National Institutes of Health. Follow-up studies based on NAS-NRC surveys of actual doctorates conferred should permit a better assessment of the validity of the results.

Table 1  
Production of Doctorates in the Biosciences, 1975-1980  
All Institutions (N = 199)

Field of Study	Number of Doctorates Conferred			Anticipated Change from 1975-76 to:			
	Actual 1975-76	Estimated		1977-78		1979-80	
		1977-78	1979-80	Number	Percent	Number	Percent
Anatomy.....	110	203	240	93	84.5	130	118.2
Biochemistry.....	488	674	716	186	38.1	228	46.7
Biology.....	509	703	706	194	38.1	197	38.7
Biometry/Biostatistics/Biomathematics	62	113	138	51	82.3	76	122.6
Biophysics.....	92	153	129	61	66.3	37	40.2
Botany.....	212	243	296	31	14.6	84	39.6
Cell Biology.....	65	108	104	43	66.2	39	60.0
Ecology.....	64	108	127	44	68.8	63	98.4
Entomology/Parasitology.....	152	225	200	73	48.0	48	31.6
Genetics.....	135	193	218	58	43.0	83	61.5
Human Pathology.....	81	113	137	32	39.5	56	69.1
Microbiology.....	386	598	648	212	54.9	262	67.9
Nutrition.....	48	92	110	44	91.7	62	129.2
Pharmacology/Toxicology.....	234	398	483	164	70.1	249	106.4
Physiology.....	233	397	435	164	70.4	202	86.7
Zoology.....	289	384	368	95	32.9	79	27.3
Other Biosciences.....	264	337	374	73	27.7	110	41.7
Total	3,424	5,042	5,429	1,618	47.3	2,005	58.6

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Table 2  
 Production of Doctorates in the Biosciences, 1975-1980  
 Public Institutions ( N = 131. )

Field of Study	Number of Doctorates Conferred			Anticipated Change from 1975-76 to:			
	Actual 1975-76	Estimated		1977-78		1979-80	
		1977-78	1979-80	Number	Percent	Number	Percent
Anatomy.....	61	123	144	62	101.6	83	136.1
Biochemistry.....	359	485	537	126	35.1	178	49.6
Biology.....	256	383	409	127	49.6	153	59.8
Biometry/Biostatistics/Biomathematics	62	113	138	51	82.3	76	122.6
Biophysics.....	56	85	78	29	51.8	22	39.3
Botany.....	203	227	275	24	11.8	72	35.5
Cell Biology.....	42	47	55	5	11.9	13	31.0
Ecology.....	54	84	98	30	55.6	44	81.5
Entomology, Parasitology.....	145	211	189	66	45.5	44	30.3
Genetics.....	113	159	172	46	40.7	59	52.2
Human Pathology.....	51	73	83	22	43.1	32	62.7
Microbiology.....	288	421	479	133	46.2	191	66.3
Nutrition.....	33	70	82	37	112.1	49	148.5
Pharmacology/Toxicology.....	146	255	314	109	74.7	168	115.1
Physiology.....	168	289	326	121	72.0	158	94.0
Zoology.....	269	360	334	91	33.8	65	24.2
Other Biosciences.....	196	257	294	61	31.1	98	50.0
Total	2,502	3,642	4,007	1,140	45.6	1,505	60.2

Table 3  
Production of Doctorates in the Biosciences, 1975-1980  
Private Institutions (N = 68)

Field of Study	Number of Doctorates Conferred			Anticipated Change from 1975-76 to:			
	Actual 1975-76	Estimated		1977-78		1979-80	
		1977-78	1979-80	Number	Percent	Number	Percent
Anatomy.....	49	80	96	31	63.3	47	98.9
Biochemistry.....	129	189	179	60	46.5	50	38.8
Biology.....	253	320	297	67	26.5	44	17.4
Biometry/Biostatistics/Biomathematics	0	0	0	0	0	0	0
Biophysics.....	36	68	51	32	88.9	15	41.7
Botany.....	9	16	21	7	77.8	12	133.3
Cell Biology.....	23	61	49	38	165.2	26	113.0
Ecology.....	10	24	29	14	140.0	19	190.0
Entomology, Parasitology.....	7	14	11	7	100.0	4	57.1
Genetics.....	22	34	46	12	54.5	24	109.1
Human Pathology.....	30	40	54	10	33.3	24	80.0
Microbiology.....	98	177	169	79	80.6	71	72.4
Nutrition.....	15	22	28	7	46.7	13	86.7
Pharmacology/Toxicology.....	88	143	169	55	62.5	81	92.0
Physiology.....	65	108	109	43	66.2	44	67.7
Zoology.....	20	24	34	4	20.0	14	70.0
Other Biosciences.....	68	80	80	12	17.6	12	17.6
Total	922	1,400	1,422	478	51.8	500	54.2

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Table 4  
 Production of Doctorates in the Biosciences, 1975-1980  
 "Top Twenty" Institutions

Field of Study	Number of Doctorates Conferred			Anticipated Change from 1975-76 to:			
	Actual 1975-76	Estimated		1977-78		1979-80	
		1977-78	1979-80	Number	Percent	Number	Percent
Anatomy.....	32	46	60	14	43.8	28	87.5
Biochemistry.....	146	163	162	17	11.6	16	11.0
Biology.....	174	209	197	35	20.1	23	13.2
Biometry/Biostatistics/Biomathematics	11	32	31	21	190.9	20	181.8
Biophysics.....	29	34	36	5	17.2	7	24.1
Botany.....	25	28	27	3	12.0	2	8.0
Cell Biology.....	11	32	29	21	190.9	18	163.6
Ecology.....	0	0	0	0	0	0	0
Entomology, Parasitology.....	9	9	9	0	0	0	0
Genetics.....	46	48	62	2	4.3	16	34.8
Human Pathology.....	25	24	38	1	-4.0	13	52.0
Microbiology.....	91	111	106	20	22.0	15	16.5
Nutrition.....	12	13	15	1	8.3	3	25.0
Pharmacology/Toxicology.....	50	67	85	17	34.0	35	70.0
Physiology.....	47	79	76	32	68.1	29	61.7
Zoology.....	37	38	37	1	2.7	0	0
Other Biosciences.....	65	75	80	10	15.4	15	23.1
Total	810	1,008	1,050	198	24.4	240	29.6

Table 5  
 Production of Doctorates in the Biosciences, 1975-1980  
 "Bottom Twenty" Institutions

Field of Study	Number of Doctorates Conferred			Anticipated Change from 1975-76 to:			
	Actual 1975-76	Estimated		1977-78		1979-80	
		1977-78	1979-80	Number	Percent	Number	Percent
Anatomy.....	0	0	0	0	0	0	0
Biochemistry.....	20	26	41	6	30.0	21	105.0
Biology.....	34	53	55	19	55.9	21	61.8
Biometry/Biostatistics/Biomathematics	0	0	0	0	0	0	0
Biophysics.....	0	0	0	0	0	0	0
Botany.....	27	20	44	-7	-25.9	17	63.0
Cell Biology.....	0	0	0	0	0	0	0
Ecology.....	0	0	0	0	0	0	0
Entomology, Parasitology.....	12	23	30	11	91.7	18	150.0
Genetics.....	2	7	11	5	250.0	9	450.0
Human Pathology.....	0	0	0	0	0	0	0
Microbiology.....	6	11	15	5	83.3	9	150.0
Nutrition.....	0	0	0	0	0	0	0
Pharmacology/Toxicology.....	0	0	1	0	0	1	0
Physiology.....	1	6	7	5	500.0	6	600.0
Zoology.....	29	55	38	26	89.7	9	31.0
Other Biosciences.....	23	19	34	-4	-17.4	11	47.8
Total	154	220	276	66	42.9	122	79.2

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Table 6  
Percentage Distribution of Doctorates in the Biosciences, 1975-1980, by Control

Field of Study	All Institutions			Public Institutions			Private Institutions		
	Actual		Estimated	Actual		Estimated	Actual		Estimated
	1975-76	1977-78	1979-80	1975-76	1977-78	1979-80	1975-76	1977-78	1979-80
Anatomy.....	3.2	4.0	4.4	2.4	3.4	3.0	5.3	5.7	6.8
Biochemistry.....	14.3	13.4	13.2	14.3	18.3	13.4	14.0	13.5	12.6
Biology.....	14.9	13.9	13.0	10.2	10.5	10.2	27.4	22.9	20.9
Biometry/Biostatistics/									
Biomathematics.....	1.8	2.2	2.5	2.5	3.1	3.4	0	0	0
Biophysics.....	2.7	3.0	2.4	2.2	2.3	1.9	3.9	4.9	3.6
Botany.....	6.2	4.8	5.5	8.1	6.2	6.9	1.0	1.1	1.5
Cell Biology.....	1.9	2.1	1.9	1.7	1.3	1.4	2.5	4.4	3.4
Ecology.....	1.9	2.1	2.3	2.2	2.3	2.4	1.1	1.7	2.0
Entomology, Parasitology..	4.4	4.5	3.7	5.8	5.8	4.7	.8	1.0	.8
Genetics.....	3.9	3.8	4.0	4.5	4.4	4.3	2.4	2.4	3.2
Human Pathology.....	2.4	2.2	2.5	2.0	2.0	2.1	3.3	2.9	3.8
Microbiology.....	11.3	11.9	11.9	11.5	11.6	12.0	10.6	12.6	11.9
Nutrition.....	1.4	1.8	2.0	1.3	1.9	2.0	1.6	1.6	2.0
Pharmacology/Toxicology..	6.8	7.9	8.9	5.8	7.0	7.8	9.5	10.2	11.9
Physiology.....	6.8	7.9	8.0	6.7	7.9	8.1	7.0	7.7	7.7
Zoology.....	8.4	7.6	6.8	10.8	9.9	8.3	2.2	1.7	2.4
Other Biosciences.....	7.7	6.7	6.9	7.8	7.1	7.3	7.4	5.7	5.6
<b>Total</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>

Table 7  
Percent Distribution of Doctorates in the Biosciences, 1975-1980, by Level of NIH Support

Field of Study	Top 20 Institutions			Bottom 20 Institutions		
	Actual 1975-76	Estimated		Actual 1975-76	Estimated	
		1977-78	1979-80		1977-78	1979-80
Anatomy.....	4.0	4.6	5.7	0	0	0
Biochemistry.....	18.0	16.2	15.4	13.0	11.8	14.9
Biology.....	21.5	20.7	18.8	22.1	24.1	19.9
Biometry/Biostatistics/Biomathematics...	1.4	3.2	3.0	0	0	0
Biophysics.....	3.6	3.4	3.4	0	0	0
Botany.....	3.1	2.8	2.6	17.5	9.1	15.9
Cell Biology.....	1.4	3.2	2.8	0	0	0
Ecology.....	0	0	0	0	0	0
Entomology, Parasitology.....	1.1	.9	.9	7.8	10.5	10.9
Genetics.....	5.7	4.8	5.9	1.3	3.2	4.0
Human Pathology.....	3.1	2.4	3.6	0	0	0
Microbiology.....	11.2	11.0	10.1	3.9	5.0	5.4
Nutrition.....	1.5	1.3	1.4	0	0	0
Pharmacology/Toxicology.....	6.2	6.6	8.1	0	0	.4
Physiology.....	5.8	7.8	7.2	.6	2.7	2.5
Zoology.....	4.6	3.8	3.5	18.8	25.0	13.8
Other Biosciences.....	8.0	7.4	7.6	14.9	8.6	12.3
Total	100.0	100.0	100.0	100.0	100.0	100.0

Appendix A: Survey Instrument

AMERICAN COUNCIL ON EDUCATION  
ONE DUPONT CIRCLE  
WASHINGTON, D. C. 20036

HIGHER EDUCATION PANEL

September 1, 1976

Dear Higher Education Panel Representative:

Enclosed is the thirty-fourth survey of the Higher Education Panel. This survey, requested by the National Institutes of Health, covers the production of doctorates in the biosciences, 1975-1980.

The purpose of the survey is to provide national estimates of doctorates awarded in fields which form the basis of biomedical research and to approximate the supply of doctorates in such fields during the remainder of the decade. Output measures of this nature are of value in assessing the need for and the impact of specific federal programs; such data also serve policy-makers in higher education and contribute to more informed career choices by students.

We are requesting that the actual counts as well as the estimates of future Ph.D. production be obtained from department heads and/or other heads of appropriate campus units where advanced degrees in the biosciences are conferred. The estimates for future doctorate production should be carefully considered and based, insofar as possible, on the number of graduate students actually enrolled in bioscience fields. Please also obtain data from medical schools and other academic components of your institution which may be geographically separate from the main campus but are still considered part of your institution.

Please take the time now to complete and return the enclosed postcard to us and distribute the survey forms to the appropriate departments.

You will note on the enclosed instruction sheet, and throughout the survey materials, that the doctorate classification includes degrees such as the Ph.D. and Sc.D. but excludes professional degrees such as the M.D. and D.V.M. Also note that the fields of agriculture and forestry are excluded from this survey.

As usual, the data you provide will be reported in summary fashion only and will not be identifiable with your institution. A copy of the printed report will be sent to you as soon as it becomes available.

We would appreciate receiving the completed questionnaires by September 24, 1976. A self-addressed, stamped envelope has been enclosed for your convenience.

Thank you for your cooperation.

Frank Atelsek

*Frank Atelsek*

Director

FA:ec  
Enclosures

American Council on Education  
Higher Education Panel  
One Dupont Circle  
Washington, D.C. 20036

Higher Education Panel Survey No. 34

Production of Doctorates in the Biosciences

1975-1980

General Instructions

Enclosed are the following:

- A. Postcard
- B. Questionnaire and attached introductory letter from NIH (12 copies)
- C. Return envelope

On the postcard, please indicate the number of departments at your institution that award the doctorate in each of the listed fields.

Please return the postcard to the Higher Education Panel as soon as possible.

Please distribute a copy of the questionnaire to each department which confers the doctorate in each of the following bioscience fields:

Anatomy  
Biochemistry  
Biology  
Biometry/Biostatistics/Biomathematics  
Biophysics  
Botany  
Cell Biology  
Ecology  
Entomology/Parasitology  
Genetics

Human Pathology (Plant and  
Animal Pathology should be  
included with "Other Biosciences")  
Microbiology  
Nutrition  
Pharmacology/Toxicology  
Physiology  
Zoology  
Other Biosciences (excluding  
Agriculture and Forestry)

(Doctorate includes degrees such as the Ph.D. and Sc. D., but excludes professional degrees such as the M.D. and D.V.M.)

A separate survey form should be used for each field. Data from any number of departments that award the doctorate in the same field - e.g., all in biochemistry -- may be reported on one survey form.

Please wait until the due date of September 24th to return all completed questionnaires in the enclosed preaddressed stamped envelope. ACE will aggregate the data for each field and institution.

Questionnaires you receive after that date should be forwarded immediately to HEP. If you have any questions, please telephone the Panel collect at 202-833-4757.



DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE  
PUBLIC HEALTH SERVICE  
NATIONAL INSTITUTES OF HEALTH  
BETHESDA, MARYLAND 20014

Dear Colleague:

As part of its continuing assessment of the Nation's resources for health research, the National Institutes of Health is seeking to develop valid estimates of the future supply of Ph.D.s in the life sciences and to anticipate, to the extent possible, prospective supply/demand imbalances.

Heretofore, available techniques for projecting biomedical research manpower by field have been only partly successful; the need exists for more reliable baseline data on expected Ph.D. production in the biosciences. To meet this need we have asked the American Council on Education to conduct this survey through its Higher Education Panel.

We hope through this survey to derive short-term estimates of doctoral output directly from the heads of the science departments involved. The data so obtained should permit us to improve our projections of doctorates in the basic medical sciences and other bioscience fields of interest.

We would greatly appreciate your cooperation in completing the attached questionnaire at your earliest convenience. As is the case with all Higher Education Panel surveys, the data will be reported in summary fashion only and will not be identifiable with any institution.

Thank you for your cooperation.

Sincerely yours,

William E. Rhode, Ph.D.  
Acting Director  
Division of Resources Analysis  
Office of Program Planning  
and Evaluation

Attachment

Please use a separate form for each field, and make extra copies of the form as needed. ACE will aggregate the data for each field and institution.

OMB# 99-R0265  
exp.6/78

American Council on Education  
Higher Education Panel Survey No. 34

List of Fields Surveyed

Anatomy  
Biochemistry  
Biology  
Biometry/Biostatistics/Biomathematics  
Biophysics  
Botany  
Cell Biology  
Ecology  
Entomology/Parasitology  
Genetics  
Human Pathology (Plant or Animal Pathology should be included with "Other Biosciences")  
Microbiology  
Nutrition  
Pharmacology/Toxicology  
Physiology  
Zoology  
Other Biosciences (excludes Agriculture and Forestry)

Production of Doctorates\* in the Biosciences  
1975-1980

Field \_\_\_\_\_

Actual number of doctorates conferred July 1975-June 1976, \_\_\_\_\_

Estimated number of doctorates to be conferred July 1977-June 1978, \_\_\_\_\_

Estimated number of doctorates to be conferred July 1979-June 1980, \_\_\_\_\_

(Note: No estimate is requested for 1976-77 or 1978-79)

\* Doctorate includes Ph.D. and Sc.D. degrees but excludes professional degrees such as M.D. and D.V.M.

PLEASE RETURN THIS SURVEY TO  
YOUR HEP REPRESENTATIVE  
BY SEPTEMBER 24TH WHO WILL  
FORWARD IT TO:

American Council on Education  
Higher Education Panel  
One Dupont Circle, N.W.  
Washington, D.C. 20036

PLEASE RETAIN A COPY  
OF THIS SURVEY FOR  
YOUR RECORDS.

NAME: \_\_\_\_\_

DEPARTMENT: \_\_\_\_\_

PHONE: \_\_\_\_\_

IF YOU HAVE ANY QUESTIONS, PLEASE CALL COLLECT 202-833-4757.

Appendix B: Methodology

At the conclusion of the survey, responses had been received from 188 of the 202 institutional members of the Higher Education Panel qualified to participate in this survey. Of these 188 respondents, however, 21 institutions neither awarded any bioscience doctorates in 1975-76 nor expected to award any during the years under consideration. Thus the number of respondents was reduced to 167.

In many instances, data for one field came from several departments within an institution. Therefore, to facilitate both keypunching and programming, all responses from an institution were aggregated by field. The total population eligible for the survey was then defined to include all colleges and universities which had awarded the doctorate in a bioscience field in 1974-75, according to NCES's Higher Education General Information Survey (HEGIS) on earned degrees conferred. These institutions numbered 199.

The population was stratified into six cells: by control (public, private) and by level of NIH support for projects and resources in FY 1973 (Top 20, Bottom 20, all other), as shown in Table B-1.

Table B-1  
Stratification Design for Weighting

Strata	Population	Respondents
Public	131	110
Top 20	7	5
Bottom 20	17	14
All other	107	91
Private	68	57
Top 20	13	13
Bottom 20	3	0
All other	52	44
Total	199	167

### Weighting

Weighting was accomplished in two stages:

First Stage. Within each of the six strata and for each field,

A. The sum of doctorate degrees conferred in 1975 was computed for all institutions in the population.

B. The sum of doctorate degrees conferred in 1975 was computed for all institutions responding to the survey by multiplying their doctoral counts by the appropriate net Panel weight (basic institutional weight; i.e., the ratio of the number of institutions in the Panel to the number of institutions in the population separately for each cell).

The total from the first step was divided by the total from the second step, yielding the first-stage weight.

$$f_{i(k)} = \frac{\sum_{j=1}^{N_i} D_{ij(k)-75}}{\sum_{j=1}^{n_i} w_{hij} d_{hij(k)-75}}$$

Where  $N_i$  = total number of population institution in stratum i

$n_i$  = total number of responding institutions in stratum i

$i = 1, 2, \dots, 6$  strata

$h = 1, 2, \dots, 18$  original strata

$k = 1, 2, \dots, 17$  bioscience fields

$D_{ij(k)-75}$  = doctorate degrees conferred in field k in 1975 by population institution j in stratum i (from HEGIS)

$w_{hij}$  = net Panel weight for institution j of strata i and h

$d_{hij(k)-75}$  = doctorate degrees conferred in field k in 1975 by responding institution j of stratum i (from HEGIS)

$f_{i(k)}$  = first-stage weight for field k of stratum i

Second Stage. The final weight for field k of stratum i was obtained by multiplying its appropriate first-stage weight by its net Panel weight:

$$W^*_{hij(k)} = f_{i(k)} W_{hij}$$

Where

$W^*_{hij(k)}$  = final weight for field k of stratum i, corresponding to institution, j of stratum h

The data were then weighted by multiplying the doctorate counts and estimates at responding institutions by their associated final weights.

#### Comparison of Respondents and Nonrespondents

Of the 235 doctorate-granting institutions in the Higher Education Panel, 188 provided usable data before the deadline for returning questionnaires. Of these respondents, 21 reported conferring no doctoral awards in the biosciences, thus reducing to 167 the number of Panel responses useful for weighting to national estimates. Table B-2 compares these 167 respondents with the remainder of the total universe of 199 doctorate-granting institutions that awarded at least one doctoral degree in a bioscience field in 1974-75.

Since the Panel is a disproportionate stratified sample, respondents differ from nonrespondents in several important respects, notably size. For example, proportionately twice as many nonrespondents as respondents enrolled fewer than 1,000 graduate students (59 percent vs. 30 percent). Of course, the stratification design for weighting the results of the present survey to national estimates adjusts for these inherent biases.

Above-average response rates were recorded for institutions enrolling more than 2,000 graduate students (94 percent) and for institutions in the West (92 percent). Lower-than-average response rates occurred among colleges enrolling fewer than 1,500 students (full-time equivalent) (62 percent) and among colleges enrolling fewer than 1,000 graduate students (72 percent).

Table B-2

Comparison of Survey Respondents with Population Nonrespondents  
(In Percentages)

Characteristic	Survey Respondents (N=167)	Population Nonrespondents (N=32)	Response Rate
Total	100.0	100.0	83.9
Control			
Public	65.9	65.6	84.0
Private	34.1	34.4	83.8
Graduate Enrollment (FTE)			
<1,000	30.0	59.4	72.5*
1,000-3,000	44.9	25.0	90.4
3,001-5,000	15.0	12.5	86.2
>5,000	10.2	3.1	94.4*
Total Enrollment (FTE)			
<1,500	9.6	31.2	61.5*
1,501-5,000	12.6	18.8	77.8
5,001-10,000	27.5	18.8	88.5
>10,000	50.3	31.3	89.4
Census Region			
East	26.3	34.4	80.0
Midwest	21.6	31.3	78.5
South	31.1	25.0	86.7
West	21.0	9.4	92.1

\*Exceeds or falls short of the overall response rate by more than 10 percent.

**Other Reports of the Higher Education Panel  
American Council on Education**

Blandford, B. and Dutton, D. **Survey of First-Year Graduate and Postdoctoral Enrollment in Science and Engineering.** Higher Education Panel Report, No. 1. August, 1971.

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Astin, A., Blandford, B., and Mahn, T. **Freshman Class Vacancies in Fall 1971 and Recent Trends in Enrollment of Minority Freshmen.** Higher Education Panel Report, No. 3. February, 1972.

**Changes in Graduate Programs in Science and Engineering 1970-72 and 1972-74.** Science Resources Studies Highlights. Washington National Science Foundation, July, 1972.

Blandford, B. and Sell, C. **Enrollment of Junior-Year Students (1970 and 1971).** Higher Education Panel Report, No. 5. April, 1972.

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Trexler, J. and Kent, L. **Commercial Theme-Writing Services.** Higher Education Panel Report, No. 7. June, 1972.

Furniss, W. T. **Faculty Tenure and Contract Systems: Current Practice.** ACE Special Report, July, 1972.

Bayer, A. E. and Astin, A. W. **War Protest on U. S. Campuses During April 1972.** Higher Education Panel Report, No. 9. May, 1972.

Blandford, B. A. and Trexler, J. C. **Expected First-Year Graduate Enrollment in Science and Engineering, Fall 1972.** Higher Education Panel Report, No. 10. August, 1972.

Blandford, B. A. **Student Participation on Institutional Governing Boards.** Higher Education Panel Report, No. 11. October, 1972.

Dutton, J. E. and Blandford, B. A. **Enrollment of Junior-Year Students (1971 and 1972).** Higher Education Panel Report, No. 12. April, 1973.

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El-Khawas, E. H. and Kinzer, J. L. **The Impact of Office of Education Student Assistance Programs, Fall 1973.** Higher Education Panel Report, No. 18. April, 1974.

El-Khawas, E. H. and Kinzer, J. L. **Enrollment of Minority Graduate Students at Ph.D. Granting Institutions.** Higher Education Panel Report, No. 19. August, 1974.

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El-Khawas, E. H. and Furniss, W. T. **Faculty Tenure and Contract Systems: 1972 and 1974.** Higher Education Panel Report, No. 22. December, 1974.

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Atelsek, Frank J. and Gomberg, Irene L. **Bachelor's Degrees Awarded to Minority Students, 1973-74.** Higher Education Panel Report, No. 24. January, 1977.

Atelsek, Frank J. and Gomberg, Irene L. **Nonfederal Funding of Biomedical Research and Development: A Survey of Doctoral Institutions.** Higher Education Panel Report, No. 25. July, 1975.

Gomberg, Irene L. and Atelsek, Frank J. **Major Field Enrollment of Junior-Year Students, 1973 and 1974.** Higher Education Panel Report, No. 26. April, 1976.

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Atelsek, Frank J. and Gomberg, Irene L. **Young Doctorate Faculty in Selected Science and Engineering Departments, 1975 to 1980.** Higher Education Panel Report, No. 30. August, 1976.

Atelsek, Frank J. and Gomberg, Irene L. **Energy Costs and Energy Conservation Programs in Colleges and Universities: 1972-73 and 1974-75.** Higher Education Panel Report, No. 31. April, 1977.

Atelsek, Frank J. and Gomberg, Irene L. **Foreign Area Research Support Within Organized Research Centers at Selected Universities, FY 1972 and 1976.** Higher Education Panel Report, No. 32. December, 1976.

Atelsek, Frank J. and Gomberg, Irene L. **College and University Services for Older Adults.** Higher Education Panel Report, No. 33. February, 1977.

Gomberg, Irene L. and Atelsek, Frank J. **Composition of College and University Governing Boards.** Higher Education Panel Report, No. 35. August, 1977.

Atelsek, Frank J. and Gomberg, Irene L. **Estimated Number of Student Aid Recipients, 1976-77.** Higher Education Panel Report, No. 36. September, 1977.

Single copies of the above reports may be obtained from the Higher Education Panel, American Council on Education, One Dupont Circle, Washington, D. C. 20036